DIACETYL
UNDERSTANDING AND CONTROL FOR BREWERS
IBA QUALITY & TECHNICAL GROUP

INDEPENDENT BREWERS ASSOCIATION

SCOPE

This fact sheet provides an overview of diacetyl and how it relates to the brewing process and beer quality. It includes discussion about the main drivers for diacetyl formation and outlines how brewers can identify and control diacetyl.

DIACETYL - WHAT IS IT?

Diacetyl is a vicinal diketone (VDK), an organic compound that is commonly formed as part of the beer fermentation process. Its aroma and flavour in beer presents as a buttery or butterscotch when present at above sensory threshold levels (0.1ppm). Diacetyl is also known to exhibit a slick or slippery mouthfeel in beer.

When considering the sensory impacts of diacetyl in beer, one must also consider the presence 2,3-pentandione. This compound is another VDK that exhibits very similar characteristics to diacetyl with a flavour threshold greater than diacetyl. Given the close relationship between these two compounds, laboratories test for overall VDK levels instead of testing for each individual compound.

It is for this reason that some brewers may refer to VDK as opposed to just diacetyl. For the purposes of this factsheet we'll just refer to both as diacetyl for simplicity.

HOW IS DIACETYL FORMED IN BEER?

FERMENTATION

During the initial lag and exponential phase of fermentation, yeast cells produce alpha-acetolactate which is a precursor for diacetyl. Some of this leaks from the yeast cell into the wort and later oxidises to become diacetyl.

BACTERIAL CONTAMINATION

Diacetyl can also be formed from microbiological contamination, particularly from lactic acid bacteria such as pediococcus and lactobacillus. These spoilage bacteria have the ability to rapidly produce high levels of diacetyl in contaminated beers.

DRY HOP CREEP

Naturally occurring enzymes exist on hops. When large dry hop loads are added to fermented wort, these enzymes are able to break down residual starches and dextrins into fermentable sugars. These reactions can occur well after the beer has been chilled and can lead to secondary fermentation of beer in package or keg resulting in formation of diacetyl above sensory thresholds.

CONTROLLING DIACETYL IN BEER

Yeast eventually reabsorbs diacetyl and converts it into acetoin and eventually to 2,3 butanediol. Both of these compounds have the ability to escape the yeast cell wall however they have high flavour thresholds and do not contribute to final beer flavour.

Providing sufficient time at adequate fermentation temperatures allows the diacetyl reduction process to occur naturally. The rate of diacetyl reduction is temperature dependant. At higher temperatures it is accelerated whereas at cooler temperatures is slowed. Consideration needs to be given to the yeast strain and physical fermentation characteristics when considering appropriate methods for managing diacetyl reduction.

Another option to control diacetyl in beer is the use of an enzyme called Alpha Acetolactate Decarboxylase, ideally at start of fermentation.

This enzyme prevents the formation of diacetyl by the decarboxylation of alpha-acetolactate to acetoin.

Brewers sometimes use this to speed up the fermentation time, and also may some add during dry hopping.

ALE YEASTS

Ale yeasts are typically fermented warm (approx. 18-20C) with no requirement for a diacetyl rest. Allowing ferments to remain at warm for approximately 2 days after terminal gravity usually provides sufficient time for diacetyl reduction to occur.

LAGER YEASTS

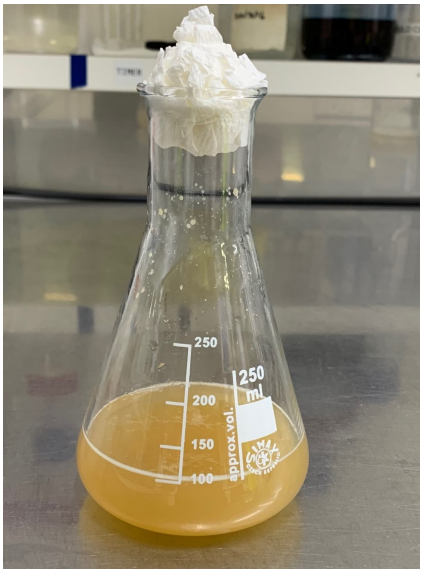
Given that lager yeasts are generally fermented at cooler temperatures, diacetyl reduction will naturally take longer to occur in such beers. Employing a diacetyl rest is a key tool in accelerating diacetyl reduction in lager beers.

DIACETYL REST

Diacetyl rests are typically only necessary for cooler lager yeast ferments. To preform a diacetyl rest, raise the fermentation temperature several degrees (typically to 16-20 degrees Celsius) late fermentation. Hold at this temperature for at least 2 days to allow terminal gravity to be reached and associated diacetyl reduction to occur. It is important to note that this process is best employed while the beer is still actively fermenting to ensure the ferment is able to naturally free rise to the desired rest temperature.

Once terminal gravity has been observed for approximately 2 days, a forced diacetyl test is recommended to determine if necessary diacetyl reduction has occurred. This is applicable to both ale and lager yeast fermentations.

FORCED DIACETYL TEST



Forced diacetyl testing is a cheap and effective means to assess your brew before it is crash chilled.

It enables brewers to use sensory evaluation to determine whether a beer has undergone sufficient diacetyl reduction prior to chilling.

The basic steps for this process are outlined below:

1) Take two small samples from fermentation vessel (FV) and place in watertight/covered containers (e.g. flask, reagent bottle).

Ideally the liquid should be filtered into the container e.g. through a coffee filter.

One sample will be a control sample and the other will undergo the forced diacetyl test.

If this equipment is not available, a basic test can be performed using a PET bottle and bucket of hot water (approx. 70C).

2) Place one sample into a hot water bath and hold at 60 - 70 °C for 20-30mins.

3) Remove sample from hot water bath and chill down to room temperature.

4) Perform sensory evaluation on both samples.

5) If no Diacetyl is detected the FV can be chilled.

If diacetyl is detected, allow fermentation to continue for another day and repeat the forced diacetyl test.